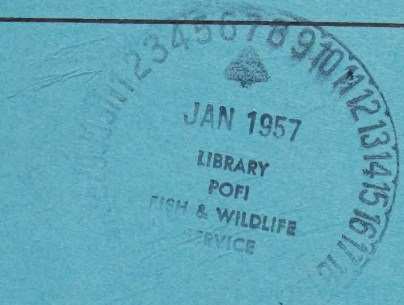


ISSUE NINETEEN
NOVEMBER - 1956



THE CANADIAN FISH CULTURIST



Published at Ottawa by
The Department of Fisheries of Canada

CONTENTS

	Page
✓ Catches of Fish in New Brunswick Streams by Direct Current Electro-fishing—H. GODFREY.....	1
Experimental Storage of Lake Trout Eggs—K. H. LOFTUS...	9
Further Improvement in Trout Angling at Crecy Lake, New Brunswick, with Predator Control Extended to Large Trout —M. W. SMITH.....	13
The Growth of Yellow Pikeperch, <i>Stizostedion vitreum</i> (Mitchill) in Three Mile Lake, Ontario—E. P. SLASTENENKO....	17

The Canadian Fish Culturist is published under the authority of the Minister by the Department of Fisheries of Canada as a means of providing a forum for free expression of opinion on Canadian fish culture. In the areas of fact and opinion alike, the responsibility for statements made in articles or letters rests entirely with the writers. Publication of any particular material does not necessarily imply that the Department shares the views expressed. In issuing The Canadian Fish Culturist the Department of Fisheries is acting only as an instrument for assisting in the circulation of information and opinion among people in the fish culture field. Those who may wish to discuss articles which have been published in The Canadian Fish Culturist are encouraged to do so and space will be made available.

Correspondence should be addressed to the DIRECTOR, INFORMATION AND EDUCATIONAL SERVICE, DEPARTMENT OF FISHERIES, OTTAWA, CANADA.

Published under Authority
of
HON. JAMES SINCLAIR, M.P.,
Minister of Fisheries

CATCHES OF FISH IN NEW BRUNSWICK STREAMS BY DIRECT CURRENT ELECTRO-FISHING

by

H. Godfrey*

Fisheries Research Board of Canada Biological Station, St. Andrews, N.B.

During the course of an investigation of the inter-specific relationship of eels, *Anguilla bostoniensis* (LeSueur), and young Atlantic salmon, *Salmo salar* Linnaeus, in New Brunswick streams in 1952, direct current electrical fishing gear was used to collect fish in 12 screened-off sections of four salmon streams. The objectives of the project were to determine how many and what kinds of fish were present in each experimental section of stream, and, from stomach analyses of the eels that were captured, to discover what fish the eels had removed during a night's feeding (eels being mainly nocturnal foragers).

The present paper is limited to describing how fishing was carried out and what fish were captured. Some descriptions of observed differences in behaviour within the electric field and of differences in catchability of the more abundant species are also included. The intention of the paper is to present the data as examples of the use of the electro-fishing technique for the purpose of making fish population estimates in natural streams, and to demonstrate what success was achieved in collecting numbers of a variety of different kinds of fish. Readers are referred to Elson (1950), and Smith and Elson (1950), for more complete presentations of the use, the limitations and effectiveness, of similar electrical apparatus.

The electrical equipment used by the writer was like the Wolf machine and its accessories which Smith and Elson have described. The operator carried the positive electrode, which was connected to the gas-driven generator by a long cable of insulated wire. The negative electrode consisted of a small square of copper screening. It was attached to the generator by a short cable and was grounded on the river bottom. In this survey a new 1,000 watt D.C. generator was used. Its electrical output was much the same as the Wolf machine. In open circuit the speed of the motor was adjusted to maintain 750 volts. Under load, while fishing, the potential supplied and the current drawn varied from 600 to 700 volts and from 1.0 to 1.7 amperes in different waters. (Field equipment to measure the electrical conductivity of the waters was not available.)

*Author's present address—Fisheries Research Board of Canada, Biological Station, Nanaimo, B.C.

Method

Because of the need to obtain eels' stomachs after they had fed during the night, fishing was begun at first light, as soon as objects in the water could be seen clearly. Sections or sites were prepared on preceding evenings by setting barrier nets across their upper and lower limits. These nets were of $\frac{1}{2}$ -inch (stretched) cotton mesh, 6 feet wide and about 70 feet long. A foot-wide strip of burlap had been stitched along the bottom lines of each, and was buried under sand and gravel to seal the nets to the river bed. The nets were held upright and taut by posts set in the gravel.

A standard fishing procedure was followed at all sites, and for each "sweep" of a site. The operator with the positive or fishing electrode started at an upper corner of the site and fished slowly across the stream and back again, from bank to bank. He swept the electrode through the water, from as far as it would reach upstream to as far as it would reach downstream, then, lifting it from the water, repeated the movement. As necessary, and to ensure completeness of sweeping, the electrode was probed more diligently among stones and under overhanging banks. A few feet downstream from the operator stood two assistants. Each had a dip-net and one had a bucket of water to hold the captured fish alive. When returning across the stream the operator walked well within the strip of bottom just covered by the downward strokes of the electrode. Thus, every foot of the stream bed was thoroughly electro-fished. The term "sweep" refers to one complete fishing of a site in the manner described. Sweeps were immediately repeated at each site until the captures of each species during the last sweep were nil or a small fraction of the total taken in previous sweeps. The numbers of sweeps varied from two to four for each site.

Although frequently stunned by the shock, very few fish were killed by it. After fishing, all unwanted fish were returned to the water. They usually appeared to be in good condition. No attempt was made to capture the numerous very small fry of various minnows.

Some physical characteristics of the 12 fishing sites are listed in Table I.

Results

The total numbers of the several species of fish captured in each site have been listed in Table II.

From the 3,003 square yards of area making up the 12 fishing sites, 2,958 fish of 14 species were taken in 36 sweeps—four sweeps at three sites, three at six sites and two only at the remaining three sites. Species taken included black-nosed dace (*Rhinichthys atratulus*), salmon fry and salmon parr, eels, sculpin (*Cottus* sp.), brook trout adults and fry (*Salvelinus fontinalis*), burbot (*Lota lota*), and "other minnows". The salmon fry probably included both native and hatchery-reared fish, since numbers of the latter had been planted in some of these streams a month or so before the experiments. "Other minnows" include certain species which were numerically unimportant at most sites and have therefore been grouped under this heading. They include: northern creek chub (*Semotilus atromaculatus*), creek chub (*Couesius plumbeus*), shiners (*Notropis* sp.), sucker fry (*Catostomus* sp.), killifish (*Fundulus diaphanus*), pumpkinseed (*Lepomis gibbosus*) and sticklebacks (*Gasterosteus aculeatus* and *Pungitius pungitius*).

Table I

Dimensions and stream characteristics of the sites fished

Site	Length ft.	Width ft.	Area sq. yd.	Maximum depth ft.	Mean depth ft.	Bottom type	Water colour	Velocity ft.-sec.	Temper- ature* °C.
1. Digdeguash R.....	91	34	344	2	1	D	medium	1.5	31
2. ".....	93	28	289	2	1	A	"	0.3	27
3. Becaguimic R.....	61	41	278	3	1½	B	clear	3.0	20
4. ".....	90	30	300	2½	1	A-B	medium	1.1	25
5. ".....	81	10	90	1	½	B	"	1.5	20
6. Cold Stream.....	80	25	222	1½	½	A-B	clear	1.0	18
7. ".....	60	33	220	1	½	A-B	"	1.0	18
8. Shiktehawk R.....	70	38	296	2	1	B	"	1.5	18
9. ".....	45	30	150	3	1½	C	"	2.5	19
10. ".....	60	37	247	2	1	C	"	1.4	19
11. ".....	80	37	329	3	2	B-C	"	1.0	19
12. ".....	63	34	238	1	½	C	"	1.6	17

A Bottom even, gravel or stones over gravel; few or no large stones or boulders.

B Bottom even, round and flat, smooth stones; little gravel; few large stones or boulders.

C Bottom uneven, little gravel; many large stones and boulders.

V Bottom uneven, bedrock, and large stones and boulders; almost no gravel.

* Approximate mid-afternoon temperatures on day of fishing.

Table II

Numbers of fish taken at the 12 sites.

Site	Eels	Salmon fry	Salmon parr	Black-nosed dace	Sculpin	Trout fry	Adult trout	Burbot	Other minnows	Totals
1. Digdeguash R.....	19	64	15	92	0	0	0	0	142	332
2. "	17	10	0	73	0	0	0	0	157	257
3. Becaguimic R.....	77	69	13	26	0	0	0	2	83	270
4. "	75	48	15	87	2	0	0	5	2	234
5. "	35	10	8	95	1	0	0	4	0	153
6. Cold Stream.....	3	219	35	70	161	2	0	11	9	510
8. "	14	49	12	45	23	33	1	0	0	177
8. Shiktehawk R.....	53	166	20	233	1	0	0	0	32	505
9. "	21	56	21	44	2	0	0	0	0	144
10. "	20	20	0	104	1	1	0	0	2	148
11. "	27	7	6	102	0	13	7	0	12	174
12. "	29	0	0	0	10	14	1	0	0	54
Totals.....	390	718	145	971	201	63	9	22	439	2,598

Tables III, IV, V and VI list, respectively, the numbers of "all fish", eels, salmon fry and black-nosed dace taken in each sweep at the nine sites where at least three sweeps were made. Data from sites where less than three sweeps were made are not included. In Table VII the catch-per-sweep of sculpin at two sites is given.

"All fish"

Table III shows that in nine sites a total of 2,264 fish was taken in the first three sweeps. The first sweeps took from 52 per cent to 80 per cent of the total catches made by three sweeps, with a mean value of 63 per cent.

Table III
Catch per sweep of "all fish" at nine sites.

Site No.	Sweeps				Totals	Sweep No. 1 per cent of total	Sweep No. 2 per cent of total	Sweep No. 3 per cent of total
	1	2	3	4*				
1	123	74	41	19	238	52	31	17
2	97	53	25	12	175	55	30	14
3	125	67	42	—	234	53	29	18
4	355	88	47	20	490	72	18	10
5	142	27	8	—	177	80	15	5
6	106	37	10	—	153	69	24	7
7	270	168	67	—	505	53	33	13
8	113	21	10	—	144	78	15	7
9	100	29	19	—	148	68	20	13
Totals	1,431	564	269	51	2,264	$\bar{x} = 63$	$\bar{x} = 25$	$\bar{x} = 12$

* Not included in total catch.

Eels

Eels were very responsive to D.C. electric stimuli (See Table IV.) When within the electrical field, they emerged from under stones and gravel, and made vigorous swimming movements towards the positive electrode. They were usually stunned, particularly the larger eels, when within a foot or so of the electrode. Their marked response appears to be related to their shape, since, as Fisher (1950) has stated, "... in general the effectiveness of the electric current is directly related ... to the voltage drop from head to tail of each individual fish". Electrified eels were usually collected with ease, partly because of their marked response to the stimulus, and partly because their long, pale and twisting, bodies were easily visible in the water.

Table IV
Catch per sweep of "eels" at nine sites

Site No.	Sweeps				Totals	Sweep No. 1 per cent of total	Sweep No. 2 per cent of total	Sweep No. 3 per cent of total
	1	2	3	4*				
1	13	2	2	0	17	77	12	12
2	58	12	5	2	75	77	16	7
3	62	8	5	—	75	83	11	7
4	3	0	0	0	3	100	0	0
5	14	0	0	—	14	100	0	0
6	29	3	3	—	35	83	9	9
7	48	3	2	—	53	91	6	4
8	20	1	0	—	21	95	5	0
9	13	6	1	—	20	65	30	5
Totals	260	35	18	2	313	$\bar{x} = 83$	$\bar{x} = 11$	$\bar{x} = 6$

* Not included in total catch.

Salmon fry

Salmon fry exhibited a marked galvanotropic response by swimming up close to the positive electrode, and by following it vigorously through the water, as long as they were able, before being stunned. Within the electric field they were usually collected with ease, since, unless stunned, they remained well off the bottom. However, because they became paralysed only after severe exposure, they were sometimes able to escape the electric field, particularly if they received a shock near its periphery, or were frightened by movements of the operators. Other species such as black-nosed dace seemed to stun more easily than salmon fry, even though they were similar to the latter in size and in shape. Furthermore, the salmon fry did not school. They tended to move more freely and extensively about the stream, avoiding the movements of the fishing crew, and remaining outside the effective range of the electric field. Schooling species (black-nosed dace and other minnows) or bottom-dwelling species (eels and sculpins) were less active. Table V shows the catch per sweep of salmon fry at nine sites.

Table V

Catch per sweep of "salmon fry" at nine sites

Site No.	Sweeps				Totals	Sweep No. 1 per cent of total	Sweep No. 2 per cent of total	Sweep No. 3 per cent of total
	1	2	3	4*				
1	4	5	0	1	9	44	56	0
2	18	20	14	4	52	35	38	27
3	23	15	10	—	48	48	31	21
4	127	49	33	10	209	61	23	16
5	33	13	3	—	49	67	27	6
6	8	1	1	—	10	80	10	10
7	99	50	17	—	166	60	30	10
8	45	7	4	—	56	80	13	7
9	10	8	2	—	20	50	40	10
Totals	367	168	84	15	619	$\bar{x} = 59$	$\bar{x} = 27$	$\bar{x} = 14$

* Not included in total catch.

Black-nosed dace

The galvanotropic response of black-nosed dace, although quite evident, seemed to be much less pronounced than that of salmon fry. They seldom came close to the positive electrode, and only rarely followed its movements. They were usually stunned quickly when very close to the electrode, and then tended to drift into concealment among the stones. Retrieving them occasioned difficulty. However, at times the electrode could be brought suddenly among a school of dace, whereupon large numbers were caught quickly. This probably accounted in part for the apparent similarity in the catchability of these fish and salmon fry.

Table VI

Catch per sweep of "black-nosed" dace at nine sites

Site No.	Sweeps				Totals	Sweep No. 1 per cent of total	Sweep No. 2 per cent of total	Sweep No. 3 per cent of total
	1	2	3	4*				
1	28	17	18	10	63	44	27	29
2	12	8	3	3	23	52	35	13
3	30	39	18	—	87	34	45	21
4	65	3	1	1	69	94	4	2
5	42	3	0	—	45	93	7	0
6	59	30	6	—	95	62	31	6
7	94	104	35	—	233	40	45	15
8	31	10	3	—	44	70	23	7
9	74	14	16	—	104	71	13	15
Totals	435	228	100	14	763	$\bar{x} = 57$	$\bar{x} = 30$	$\bar{x} = 13$

* Not included in total catch.

Sculpin

Two sites provided almost all the sculpins that were caught. The proportions taken in the first sweep suggest a high catchability, yet sculpin were difficult to capture. Their galvanotropic responses showed nothing unusual. They approached the electrode but usually remained on the bottom, seldom attempting to swim upwards towards it. Becoming stunned easily, they sank among the stones, where their mottled colouring made them difficult to detect. Their high rate of capture resulted in part from the extra effort expended to discover and collect them.

Table VII

Catch per sweep of sculpin at two sites

Site No.	Sweeps				Totals	Sweep No. 1 per cent of total	Sweep No. 2 per cent of total	Sweep No. 3 per cent of total
	1	2	3	4*				
4	110	31	13	7	154	71	20	8
5	17	3	3	—	23	74	13	13
Totals	127	34	16	7	177	$\bar{x} = 72$	$\bar{x} = 19$	$\bar{x} = 9$

* Not included in total catch.

Other fishes

Altogether 63 trout fry were taken, 33 from one site. In the latter site the first sweep took 79 per cent of the total catch by three sweeps. Trout fry responses to the electrical stimulus appeared to be very similar to those of salmon fry, although their following of the electrode through the water was less pronounced.

A total of 145 salmon parr was caught in nine sites. These fish were taken often along the lower barrier nets, or among stones in its vicinity. When not able to avoid the electric field, they usually remained close to the electrode and followed its movements until captured, or until they were stunned from prolonged exposure.

Larvae (*Ammocoetes*) of the sea lamprey (*Petromyzon marinus*) were common in the mud of the banks at most sites. They were not collected. Although similar in shape and size to small eels, their galvanotropic behaviour seemed distinctly different. They were less affected by the electric current, for, although responding positively by rapid emergence from the mud, and swimming towards the electrode, they usually soon attempted, and frequently succeeded, in escaping the field.

Summary and Discussion

The combined area of the 12 experimental sites was 3,003 square yards, from which 2,958 fish, belonging to 14 different species, were taken. After thorough and repeated electro-fishing of each site, the total captures were considered to be close estimates of the total numbers of fish of each species present. In all instances, the final fishing of an area yielded only a small fraction of the total number of fish taken in the area.

The fish that were captured included species such as eels, sculpin and burbot, that are usually very difficult to capture with seines. The stream bottoms included types with many large boulders and overhanging banks that would have made seining a very inefficient means of capturing large proportions of the fish present. In these tests the type of stream bottom did not greatly affect the success of electro-fishing.

Because the main objective was the rapid capture of as many fish as possible, only incidental observations were made of apparent differences between species in their responses to the direct current stimulus. In general, fish that exhibited a marked galvanotropic response, such as eels particularly, and salmon fry, were collected most readily. However, as already explained, relatively high rates of capture were also obtained with apparently less responsive species, either by making use of their schooling behaviour (black-nosed dace), or by expending greater effort to retrieve affected fish (sculpin).

The success of the electro-fishing depended greatly upon the facts that all the experimental sections were shallow (between one and three feet in depth), and that the electrical conductivity of the water was suitable for the apparatus in use, and provided a fairly wide electric field. Because the gear, including the barrier nets, weighed about 400 pounds, fishing sites were usually selected within a few hundred yards from road transportation.

Literature Cited

- ELSON, P. F., 1950. *Usefulness of electrofishing methods.* Can. Fish Cult. 9:3-12.
 FISHER, K. C., 1950. *Physiological considerations involved in electrical methods of fishing.* Can. Fish Cult. 9:26-33.
 SMITH, G. F. M., and P. F. ELSON, 1950. *A direct current electrical fishing apparatus.* Can. Fish Cult. 9:34-46.

EXPERIMENTAL STORAGE OF LAKE TROUT EGGS

by

K. H. Loftus

District Biologist, Department of Lands and Forests, Sault Ste. Marie, Ont.

At the Huron Street Hatchery of the Ontario Department of Lands and Forests, Sault Ste. Marie, Ont., during 1948, and again in 1953, the mortality among lake trout eggs during incubation, and among the very young fry, was exceptionally high, reaching seventy-five per cent in 1953.

In both years high water temperatures appeared to be associated with: (1) rapid rate of egg development, (2) high mortality of eggs, (3) high incidence of blue sac among fry, and (4) high mortality of fry. Figure 1 presents, for three years, the average weekly temperature of the hatchery water supply during the incubation periods. Below this figure are shown the incubation periods and the total mortalities for those years.

In an attempt to avoid these apparent effects of high temperature, the following work was done to determine if it was possible to store lake trout eggs after fertilization until water temperatures at the hatchery became suitably low.

Methods—1950-1951

Twenty-four trays, each containing 7,000 fertilized lake trout eggs, were collected by a single spawn-taker in one day at Lake Superior's Montreal River. These trays were packed within the usual wooden container in sphagnum moss covered with crushed ice in accordance with normal procedure. Upon arrival at the hatchery on October 2, trays numbers one to six, constituting control A, were immediately placed in incubation in separate numbered baskets. Tray No. 7 was placed in incubation on October 4, No. 8 on October 6, No. 9 on October 8, and so on until trays numbered 20 to 24, constituting control B, having been stored in the shipping box for twenty-eight days, were placed in incubation on October 30. The stored eggs were watered lightly daily and their supply of crushed ice was renewed whenever necessary. This method of storage kept the temperature of the eggs near 40°F.

Beginning twenty-four hours after being first placed in incubation, dead eggs were picked from each tray daily at about the same time by one person. Daily egg mortalities for each tray were recorded for one hundred and twenty days, by which time egg mortality had decreased to, and remained at, almost zero.

Results

Initial (losses after twenty-four hours in incubation) and total (accumulated daily losses at the end of the experiment) egg mortalities are presented in Figure 2.

FIGURE 1

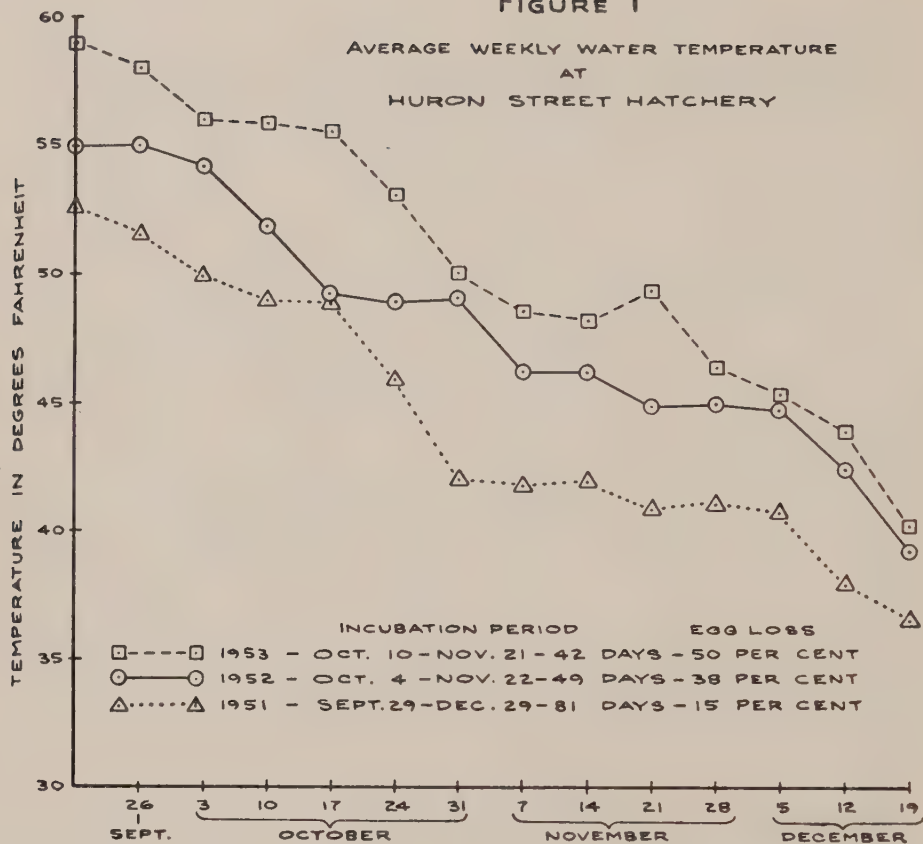
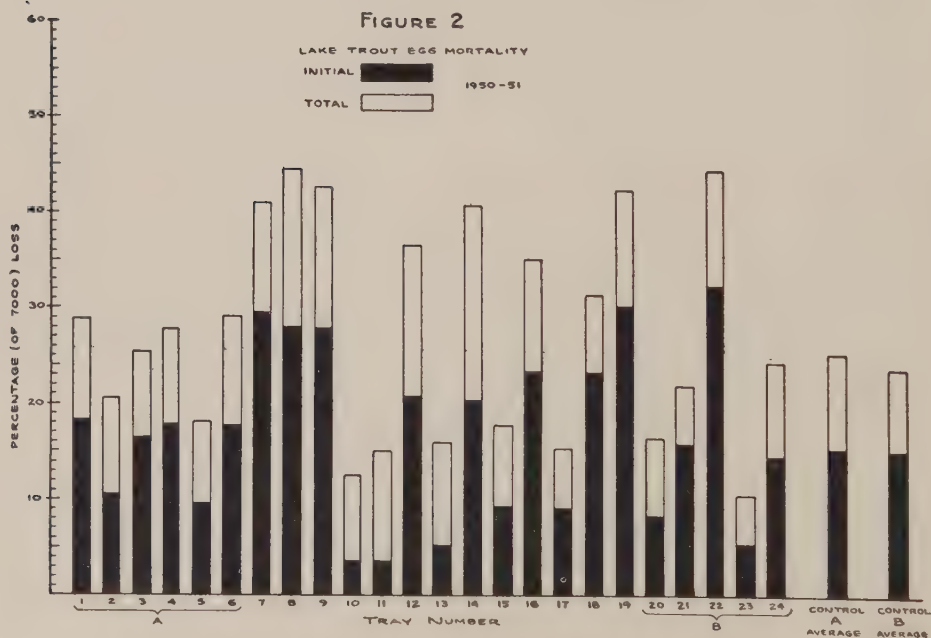


FIGURE 2



The average total loss among the trays in control A was 25·10 per cent. Among the stored eggs there was no appreciable trend towards increased total loss with increased storage time. In control B trays, which as previously mentioned had been stored for twenty-eight days before incubation, the average total loss was 23·76 per cent.

Initial losses were considerable in all trays and there were marked differences in both initial and total losses between trays. Differences in initial losses appeared to be mainly responsible for the wide differences of total losses between trays.

Discussion

It was rather unfortunate that the test was made in 1951, a year of favourable water temperatures at the hatchery. Because of this there was no abnormal loss among the eggs in control A trays which were immediately incubated. Thus, although the test failed to demonstrate any substantial reduction of losses through storage, since the opportunity was lacking, it did demonstrate that losses were not at all increased by storage. It seems reasonable to infer that the loss among stored eggs would be similar to this in years when unfavourable hatchery water temperatures cause high mortality among the incubating eggs.

No particular significance, pertinent to this experiment, is attached to the wide differences in mortality between trays. It is considered that these represent varying degrees of success in fertilization by the spawn-taker.

A similar test in another year, the results of which are not included, was in general agreement with these observations. In that test our egg fertilization was much more consistent and little variation in total losses between trays was evident. Also clearly demonstrated was that initial egg mortality increased with the duration of storage time, though total mortality remained quite constant. Incubation was, therefore, proceeding in the stored eggs, but at a rate depressed by the 40°F temperature.

Summary

Occasional high losses of eggs and fry of lake trout appeared to be caused by rapid rate of development associated with high water temperatures. It was demonstrated that embryo development can be retarded by storage for up to twenty-eight days at 40°F without increasing the total mortality above that which would be expected under favourable incubation temperatures.

FURTHER IMPROVEMENT IN TROUT ANGLING AT CRECY LAKE, NEW BRUNSWICK, WITH PREDATOR CONTROL EXTENDED TO LARGE TROUT

by

M. W. Smith

Fisheries Research Board of Canada, Biological Station, St. Andrews, N.B.

At Crecy Lake, Charlotte County, New Brunswick, hatchery-reared brook trout have been planted, the waters of the lake enriched with commercial fertilizers, and the control of trout enemies undertaken in attempts to improve the angling. Spawning conditions at Crecy Lake are poor. Planting was necessary to have a good supply of trout in the lake for testing fertilization and predator control. The results of these actions on the number and growth of trout taken by the anglers during the period from 1943 through 1953 have been fully discussed in previous publications (Smith, 1952a, 1955). However, the work at Crecy Lake has continued. This report gives results for two additional years, 1954 and 1955.

A guardian has resided at 50-acre Crecy Lake throughout each year. Planted hatchery-reared trout have been marked by fin-clipping. The trout captured by the anglers during each angling season have been counted and measured and examined for missing fins.

Summary of 1943-1953 Results

Poor catches of trout by the anglers from lakes of Charlotte County, New Brunswick, are associated with small quantities of plant foods in the waters. Planting hatchery-reared trout in these lakes has proved ineffective (Smith, 1952b). In 1946, commercial fertilizers (one ton of ammonium phosphate and 500 pounds of potassium chloride) were added to Crecy Lake in an attempt to raise its productive level and the yield of trout to anglers. The application amounted to 6.5 pounds of the fertilizers per acre-foot of water. An improved growth rate and survival of planted trout followed. Three-inch fingerling trout planted in September, 1946, grew to an average length of 8½ inches by May and June, 1947. The improved growth rate continued through the next two years but survival sharply declined. Greater numbers of fish-eating birds and mammals (loon, osprey, kingfisher, otter and mink) appeared to be attracted to the lake by the annual planting of trout. Control of these predators, by killing or frightening them from the lake, was begun in August, 1949. Trapping of eels in the lake was begun in 1950. The survival of planted trout to the anglers' catches improved substantially; however, this was accompanied by a slower growth rate. These findings led to a second comparable fertilization in 1951. In order to utilize anticipated beneficial effects more fully the number of planted trout was

doubled. As may be seen in Tables I and II, planting, fertilization and predator control in combination, but not singly, resulted in much better angling in Crecy Lake. The number of trout taken each year by the anglers rose from a low of 39 in 1949 to 3,276 in 1953. The rate of capture improved $9\frac{1}{2}$ times.

Anglers' Catches Increase in 1954

Predator control was continued in 1954 on the same basis as before. The double rate of planting begun in 1951 was also continued in 1953. From these plantings, and from survivors of former plantings, the anglers took 4,074 trout from Crecy Lake in 1954—the highest number to that year (Table II). Also the rate of capture (2.6 trout per hour of fishing) was the best to that time. Although the survival of planted yearlings was unaccountably down from 1953, that of the planted fingerlings was improved (Table I). The growth of the planted fingerlings was somewhat less but as yearlings they were still acceptable to the anglers. The fingerlings planted in 1953 contributed 67 per cent by number and 43 per cent by weight to the anglers' catches in 1954. Since the average size of the trout was smaller, the yield by weight was less (by 5.2 pounds per acre) than in 1953. However, a greater proportion of the weight resulted from growth made by the trout in the lake after planting.

Further Increase in Catches in 1955 with Reduction in Numbers of Older Trout in the Lake

To 1954 the predator control involved fish-eating birds, mammals, and eels. Eels and large trout are the only fish in Crecy Lake that can eat small trout. If the number of larger trout in Crecy Lake were reduced, would a better survival of planted fingerlings result? It is more economical to plant fingerling than yearling trout, if by so doing good yields to the anglers can be maintained. In 1954 only fingerlings were planted. Also, 110 yearling trout were removed by gill-netting during late summer and early fall of 1954. Thus, predator control was extended to include older trout. The fingerlings planted in 1954 had about one-tenth the number of older trout as possible predators, as compared with the fingerlings introduced in 1953.

In 1955 the anglers took the largest number (5,623) of trout for any year during the entire study period (Table II). The rate of capture (3.2 trout per hour) was also the best during the investigation. This catch largely resulted from the remarkably high recovery of 41.4 per cent of the fingerlings planted in 1954 (Table I). Some fish from this planting, but an unknown number, still remain in the lake. This survival was twice as good as from any previous planting of fingerlings. Extension of predator control to the reduction in the number of older trout in the lake appeared to improve the survival rate of the planted fingerlings.

Is Predator Control Alone Sufficient?

Predator control was combined with other procedures in order to improve angling at Crecy Lake. Planting was necessary to provide a supply of trout. Fertilization improved the growth rate of the trout so that yearlings were of acceptable angling size. However, the effects of predator control on the angling were so striking as to

Table I
Growth and survival of planted trout in Crecy Lake.

Stock	Year of planting	Number planted	Average length* in inches when planted	Average length in inches when angled the following year	Percentage survival to anglers' catches
Yr.....	1944	675	11.5	14.4 (1946)	0.9
Yr.....	1945	812	7.5	10.1	10.1
Lake fertilized in June, 1946					
F.....	1946	6,701	3.2	8.5	4.3
Yr.....	1946	659	8.4	11.4	16.8
F.....	1947	6,684	2.9	9.3	0.8
Yr.....	1947	675	8.4	12.2	3.9
F.....	1948	6,575	2.4	8.4	0.4
Yr.....	1948	675	6.4	11.9	1.8
Predator control of fish-eating birds and mammals begun in August, 1949					
F.....	1949	6,750	2.6	7.5	1.9
Yr.....	1949	675	7.3	10.5	28.5
Trapping of eels in lake begun in June, 1950					
F.....	1950	6,750	3.3	6.7	19.8
Yr.....	1950	675	7.3	9.8	45.3
Second fertilization in June, 1951, and stocking rate doubled					
F.....	1951	14,160	3.2	6.8	11.7
Yr. (1)....	1951	674	10.1	10.4	81.9
Yr. (2)....	1951	675	7.0	8.7	36.2
F.....	1952	13,438	2.6	6.6	16.1
Yr. (1)....	1952	675	10.5	11.3	85.0
Yr. (2)....	1952	675	8.4	10.3	88.4
F.....	1953	13,390	2.9	6.1	22.0
Yr. (1)....	1953	675	9.8	10.3	79.4
Yr. (2)....	1953	675	7.8	8.5	55.9
F.....	1954	13,227	3.9	6.1	41.4**

No yearling trout planted and the number of older trout in the lake reduced by netting in 1954

*Fork length.
**Survival to end of 1955 angling season; some trout from the 1954 planting still remain in the lake.
F.—Fingerlings; trout in their first year of life.
Yr.—Yearlings; trout in their second year of life.

Table II
Yield of trout to anglers from Crecy Lake

Year	1943	1944	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
Number caught.....	166	148	139	425	110	39	264	1,441	2,418	3,276	4,074	5,623
Average number per rod-hour	0.5	0.5	0.6	1.0	0.3	0.2	0.6	1.4	1.6	1.9	2.6	3.2
Pounds per acre.....	2.2	1.5	1.4	3.6	1.6	0.9	2.9	6.4	11.4	18.1	12.9	10.7

suggest that worthwhile improvements in trout catches could follow its application alone on lakes. Improvement would, of course, depend upon having a suitable stock of native trout. Control measures should also be directed against any predacious fish that might be present.

Because of the small size of Crecy Lake and the presence there of a resident guardian, the control of fish-eating birds and mammals was thorough. Would a less complete control of these predators result in a reasonably good improvement in trout angling? Less control would be realized if a guardian were stationed on a large lake or if he patrolled a group of small lakes. Such modifications of predator control could be tested.

Acknowledgments

The hatchery stock used in these experiments was supplied through the co-operation of the Fish Culture Branch of the Federal Department of Fisheries from its Saint John, N.B., hatchery. This paper is published with permission of the Fisheries Research Board of Canada.

Summary

Published results show that stocking, fertilization and predator control of fish-eating birds and mammals and the eel resulted in much improved fishing for brook trout in Crecy Lake, New Brunswick, during the period 1943-1953. Results are presented for 1954 and 1955. Predator control was continued. Of fingerlings and yearlings planted in 1953 anglers subsequently captured 22 and 68 per cent respectively. Predator control was extended to a reduction of older trout in the lake in 1954. Only fingerlings were planted. In 1955, the high survival of 41 per cent of these to the anglers' catches was realized, well illustrating the value of predator control.

Literature Cited

- SMITH, M. W., 1952a. *Fertilization and predator control to improve trout production in Crecy Lake, New Brunswick*. Canadian Fish Culturist, No. 13, pp. 33-39.
 1952b. *Limnology and trout angling in Charlotte County lakes, New Brunswick*. J. Fish. Res. Bd. Canada, 8(6), 383-452.
 1955. *Fertilization and predator control to improve trout angling in natural lakes*. Ibid., 12(2,) 210-237.

THE GROWTH OF YELLOW PIKEPERCH, *STIZOSTEDION VITREUM* (MITCHILL) IN THREE MILE LAKE, ONTARIO

by

E. P. Slastenenko

University of Toronto and the Ontario Department of Lands and Forests

For a number of years anglers have complained of the small size of yellow pike perch *Stizostedion vitreum* (Mitchill), taken in Three Mile Lake, Ontario. Fish were abundant but only a small proportion of those taken were of legal size (13 inches fork length). The purpose of this study was to determine the rate of growth of the yellow pike perch as the first step in learning why the lake was producing fish of such small size.

Three Mile Lake in Watt Township, District of Muskoka, is connected to Lake Rosseau and the main waters of the Muskoka River drainage by the Dee River. The lake is elongated with a long bay extending to the north. The length of the main arm is about five miles, the average width about one mile, and the total area about 2,170 acres. In the western part of the lake there are two small islands and several tributary streams, the main ones being Six Mile and Ufford creeks. The average depth in the main basin is about 10 feet with a maximum depth of 17 feet. The north basin, connected to the main basin by a narrow channel, has an average depth of 25 feet and a maximum depth of 46 feet.

The lake has 10 tourist camps and more than 50 private cottages on the shores. It is subjected to relatively heavy fishing pressure. While yellow pikeperch and smallmouth bass are the gamefish most sought by the anglers, yellow perch and brown bullhead are also taken. Other species occurring in the lake are pumpkinseed, white sucker, cisco, western golden shiner and several species of cyprinids and percids.

Methods and Material

The growth study is based on scale collections from 290 pikeperch taken during the April spawning runs in 1952, 1953 and 1954 and from fish taken in gillnets during the summer and fall of 1952 and 1954. A small sample of 41 fish taken by angling in the latter year was also obtained. In addition scales from 22 yellow pickerel transferred from Three Mile to Kashe Lake in the spring of 1953 were taken from fish in the latter lake on October 1, 1954.

Scale samples were taken midway along the body below the lateral line. Total and fork length were measured to the nearest quarter-of-an-inch, and weight in pounds and ounces was recorded. Scales were examined under a low-power binocular and the number of annuli counted.

Table I
Length—frequency distribution of 476 yellow pickerel from Three Mile Lake taken during the years 1952 to 1954, inclusive.

Age group	Fork length in inches																	Total frequency		
	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22		23	24
I+.....	11	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	12
II+.....	5	7	17	5	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	34
III+.....	—	—	6	17	11	1	—	—	—	—	—	—	—	—	—	—	—	—	—	35
IV.....	—	—	3	13	64	37	5	2	1	—	—	—	—	—	—	—	—	—	—	125
IV+.....	—	—	—	—	11	17	4	1	—	—	—	—	—	—	—	—	—	—	—	33
V.....	—	—	—	2	28	46	47	19	5	—	—	—	—	—	—	—	—	—	—	147
V+.....	—	—	—	—	4	10	21	6	1	1	—	—	—	—	—	—	—	—	—	43
VI.....	—	—	—	—	1	2	1	3	1	3	1	1	—	—	—	—	—	—	—	11
VI+.....	—	—	—	—	—	—	2	3	5	8	1	—	1	—	—	—	—	—	—	21
VII.....	—	—	—	—	—	—	—	—	2	3	1	—	—	—	—	—	—	—	—	5
VII+.....	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	2
VIII.....	—	—	—	—	—	—	—	—	—	—	—	1	—	—	1	—	1	—	—	2
VIII+.....	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	2	1	—	—	5
IX.....	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1
Frequency.....	16	8	26	37	119	113	80	34	15	16	2	2	2	1	1	2	1	—	1	476

Growth

The length-frequency distribution for each age group is presented in Table I. Fish taken in April during spawning showed no marginal growth and their ages are designated I, II, III, etc. Fish taken later in the year from August 21 to October 7 and showing marginal growth on the scales are designated I+, II+, III+, etc. In the summer samples which include age groups I+ to IX, age groups IV, IV+, V and V+ were predominant and comprised 75 per cent of the total catch. These ages also make up the main spawning run with individuals in the age groups III, VI, VII, and VIII occurring only occasionally.

Table II

The average lengths and weights of age groups of yellow pikeperch from Three Mile Lake 1952 to 1954, calculated to end of year.

Age Group	Number	Total length in inches	Fork length in inches	Total Weight in ounces	Length increment
I	12	4.8	4.5	0.9	—
II	34	7.2	6.7	2.4	2.4
III	35	9.3	8.6	4.6	2.1
IV	158	11.5	10.6	7.9	2.2
V	190	12.4	11.7	10.6	0.9
VI	32	14.4	13.5	19.9	2.0
VII	7	15.0	14.3	54.0	0.6
VIII	7	19.7	18.5	54.2	4.7
IX	1	24.5	23.1	—	4.8

The average fork and total lengths of fish calculated back to the end of the previous year are shown in Table II. These data show that the yellow pikeperch of Three Mile Lake reach a total length of 4.8 inches at the end of their first year of life. After the first year, the annual increase in length falls off sharply and then gradually lessens with age. The average length in inches and weight in ounces of the fish have been plotted against the age, in Figure 1. The change in the slopes of the age-weight and length-age relationships indicates that after the third growing season fish begin to grow more rapidly in weight than in length.

The average annual increase in length for ages II, III, IV and VI is about two inches a year but age V appears to grow slowly for reasons not as yet known. One 13-year-old fish not shown in Table II reached a total length of 29 inches.

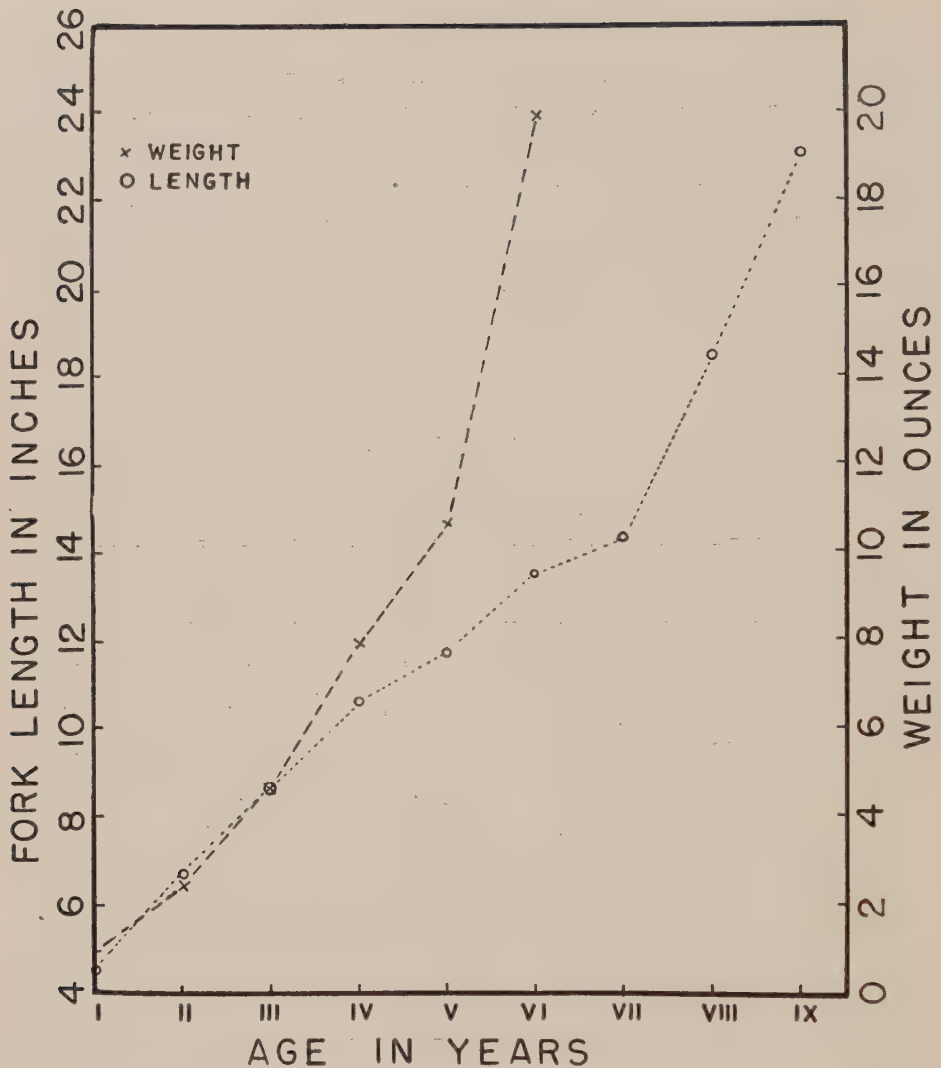


Figure 1. The average fork length and weight of pikeperch of different ages from Three Mile Lake, Ontario.

In Table III the growth data from Three Mile Lake is compared with that displayed by pikeperch in other waters according to Eschmeyer (1950). These data show that during the first year the growth of the yellow pikeperch in Three Mile Lake is close to the average of those in the other waters but from the second to seventh year growth is well below the average.

The growth rate of the Three Mile Lake pikeperch, when compared with that of Lake Abitibi, Hart (1928), shows that their growth for the first six years of life is approximately similar, and that after six years the yellow pikeperch in Three Mile Lake grow considerably faster than those in Lake Abitibi.

Table III

The growth of yellow pickerel in Three Mile Lake compared with the growth of this species in other waters as reported by Eschmeyer (1950)

Water	Number of specimens	Average total length in inches at end of year									
		I	II	III	IV	V	VI	VII	VIII	IX	X
Canada:											
Three Mile Lake.....	476	4.8	7.2	9.3	11.5	12.4	14.4	15.0	19.7	24.5	—
Lake Abitibi.....	33	—	8.0	—	11.5	11.9	12.8	13.9	17.5	17.7	18.2
Lake Nipigon.....	84	5.7	7.8	9.4	12.6	14.2	14.3	15.2	18.5	19.3	20.7
Lake Manitoba.....	1,225	—	—	11.4	13.0	14.9	16.2	17.1	17.9	19.7	19.9
Lake Erie.....	25	4.7	8.3	11.1	13.6	15.6	17.6	19.4	21.1	22.6	24.1
Prairie Provinces.....	1,430	4.2	8.4	11.3	14.8	18.0	20.8	—	—	—	—
Quetico, Ontario.....	—	7.4	10.5	13.2	15.0	16.3	17.7	18.8	19.5	19.8	20.1
U.S.A.:											
Minnesota lakes.....	6,599	4.6	8.6	12.0	15.0	18.1	20.5	22.9	25.2	26.7	—
Lake Gogebic, Mich.....	519	4.6	9.4	12.1	14.2	15.8	17.2	18.0	18.8	19.5	20.0
Iowa lakes.....	216	5.0	9.2	12.4	15.0	17.1	18.6	19.9	21.5	23.2	24.7
Trout Lake, Wis.....	429	5.3	9.7	13.7	16.6	19.0	20.7	21.7	22.3	23.1	23.3
Wisconsin waters.....	1,132	5.4	9.8	13.2	15.9	17.8	19.5	21.8	23.3	24.8	26.1
Lake of the Woods, Minn.....	2,898	6.4	9.3	11.5	13.5	14.9	16.7	18.3	19.9	21.6	22.7
Clear Lake, Iowa.....	319	5.9	10.9	14.5	17.2	19.3	21.4	23.6	26.3	27.0	27.7
Average, all waters.....	15,472	5.4	9.0	12.0	14.4	16.1	17.8	18.9	21.0	22.4	22.5

There is a small difference in the rates of growth of the sexes in Three Mile Lake. The males and females grow at approximately the same rate for the first three years, after which the females grow a little faster than the males. The growth of the sexes is compared in Table IV.

Table IV

The average fork length (calculated to annulus formation) male and female pikeperch from Three Mile Lake.

Age	Sex	Number of specimens	Fork length in inches
II	♂ ♂	15	7.5
	♀ ♀	8	7.2
III	♂ ♂	28	8.6
	♀ ♀	4	8.7
IV	♂ ♂	112	10.5
	♀ ♀	28	11.0
V	♂ ♂	108	11.5
	♀ ♀	73	12.3
VI	♂ ♂	3	12.4
	♀ ♀	22	14.0

Some information on growth was obtained from measurements of tagged fish recaptured by anglers and in gillnets. In 1954 a total of 1,862 pikeperch were tagged and released in Three Mile Lake during the spawning run which occurred between April 16 and 20. A total of 35 fish were recaptured during the spring and summer of 1954. An analysis of these data shows that the growth increment of the tagged fish recaptured in 1954, between July 9 and August 27, averaged about 0.01 inches a day or approximately 50 per cent of the estimated annual increment.

In the spring of 1953 pikeperch from Three Mile Lake were introduced into Kashe Lake, a bigger lake where this species did not occur. This experiment was done to see what improvement in the growth might occur. On October 7 of the next year 23 of these fish were recaptured. All except two of these fish were 6-year-olds. The Kashe Lake fish averaged 14.5 inches in fork length (calculated to annulus formation) while those of the same age class remaining in Three Mile averaged 13.5 inches. The move into virgin waters had caused some improvement in growth. Therefore, the slow growth of the pikeperch in Three Mile Lake can be explained tentatively on the basis of the absence of sufficient food for all the fish present. It is, however, possible, that the fish with the best rate of growth were introduced into Kashe Lake.

Table V

The length-weight relationship and coefficient of condition of Three-Mile Lake pikeperch.

Number of fish	Average standard length in m.m.	Average weight in grams	Average K
2	137	28	1.09
18	150	43	1.27
4	175	71	1.32
24	199	99	1.26
11	215	128	1.29
12	226	156	1.35
14	238	184	1.36
7	247	213	1.41
13	259	241	1.40
7	277	269	1.26
8	277	298	1.40
10	293	326	1.30
6	291	354	1.44
2	300	383	1.42
4	300	411	1.52
3	336	439	1.16
145		Grand average	1.38

Length-weight Relationship

The length-weight relationship of 145 pikeperch from Three Mile Lake and the coefficient of condition, or K factor, are presented in Table V. The K factor has been determined by using the formula:

$$K = \frac{W \cdot 10^5}{L^3}$$

where: W = weight in grams

and: L = standard length in mm.

The mean K for all size groups and the grand average K are lower here than in most lakes, indicating relatively poor growing conditions for the pikeperch in Three Mile Lake. It was found also that the coefficient tended to improve indicating fatter fish with increase in age.

Summary and Conclusion

The Three Mile Lake pikeperch grow fairly uniformly and relatively slowly. In the older age groups the rate of weight increase is faster than the rate of length increase.

The yellow pikeperch reach a total length of 4.8 inches, in their first year which is about average when compared with growth rates reported from other waters but growth thereafter is relatively poor.

An analysis of the growth of tagged fish shows that increment averages about 0.01 inches a day in the period April 20 to August 27.

There is a small difference in the rates of growth of the sexes after the third year, when the females grow faster.

The coefficient of condition for the Three Mile Lake population averaged 1.38 and tended to vary with the age of the fish. This figure is somewhat lower than that reported from most other waters and may reflect poorer growing conditions.

The fish from Three Mile Lake introduced into Kashe Lake show a little faster growth, since apparently there is not sufficient food for the Three Mile Lake population.

Acknowledgments

This study formed part of a project undertaken by the Ontario Department of Lands and Forests. The author wishes to thank Dr. F. E. J. Fry of the University of Toronto for the opportunity to carry out this work, and F. A. Walden and N. S. Baldwin of the Ontario Department of Lands and Forests for their assistance in collecting material.

References

- ADAMSTONE, F. B., 1922. Rates of Growth of the Blue and Yellow Pike Perch. (*Stizostedion vitreum*) in Lake Erie. Univ. of Tor. Pub. Biol. No. Pub. Ont. Res. Fish. Res. Lab. No. 5, pp. 77-86.
- BAJKOV, ALEXANDER, 1930. Fishing industry and fisheries investigations in the Prairie Provinces, Trans. Am. Fish. Soc. Vol. 60, pp. 14.
- CARLANDER, KENNETH D. 1943. Age, Growth, Sexual Maturity and Population fluctuations of the Yellow Pike-perch. *Stizostedion vitreum vitreum* (Mitchill) with reference to the Commercial Fisheries, Lake of the Woods, Minnesota. Trans. Am. Fish. Soc. Vol. 73, pp. 90-107.
1948. Growth of Yellow Pikeperch. *Stizostedion vitreum vitreum* (Mitchill) in some Iowa Lakes, with a summary of growth rates reported in other areas. Iowa State Coll. Journ. Sci., 22:(3) :227-235.
- CLEARY, ROBERT E. 1949. Life History and management of the Yellow Pikeperch, *Stizostedion vitreum vitreum* (Mitchill) of Clear Lake, Iowa. Iowa State College Journ. Sci. Vol. 23, No. 2, pp. 195-208.
- DEASON, HILARY J. 1933. Preliminary report on the growth rate, dominance and maturity of the pikeperches (*Stizostedion*) of Lake Erie. Trans. Am. Fish. Soc., Vol. 63, pp. 348-360.
- EDDY, SAMUEL, and KENNETH CARLANDER, 1939. The growth rate of wall-eyed pike *Stizostedion vitreum* (Mitchill) in various lakes of Minnesota. Proc. Minn. Acad. Sci., Vol. 7, pp. 44-48.
- ESCHMEYER, PAUL H. 1950. The Life History of the Walleye, *Stizostedion vitreum vitreum* (Mitchill), in Michigan, Mich. Dept. of Conservation. Bull. Inst. Fish. Res. No. 3, pp. 1-93.
- HART, JOHN L. 1928. Data on the rate of growth of Pike Perch (*Stizostedion vitreum*) and Sauger (*S. canadense*) in Ontario. Univ. Toronto. Pub. Biol. Ser. Ont. Fish Res. Lab. No. 39, pp. 45-55.
- KENNEDY, W. A. 1949. Relationship of length, weight and sexual maturity to age in three species of Lake Manitoba fish. Fish. Res. Bd. Can., Bull. 81, 5 pp.
- LINDEBORG, R. G. 1941. Records of fishes from the Quetico Provincial Park of Ontario, with comments on the growth of the yellow pike-perch. Copeia, No. 3, pp. 159-161.
- RANEY, EDWARD C., and ERNEST A. LACHNER, 1942. Studies of the summer food, growth, and movements of young yellow pike-perch, *Stizostedion v. vitreum*, in Oneida Lake, New York. Journ. Wildlife Management, Vol. 6, No. 1, pp. 1-16.
- ROSE, EARL T. 1951. Notes on the age and growth of Spirit Lake yellow pikeperch (*Stizostedion v. vitreum*) Iowa Acad. Sci., 58:517-525.
- SCHLOEMER, CLARENCE L. and RALPH LORCH. 1942. The rate of growth of the wall-eyed pike, *Stizostedion vitreum* (Mitchill), in Wisconsin's inland waters, with special reference to the growth characteristics of the Trout Lake population, Copeia, No. 4., pp. 201-211.
- STROUD, RICHARD H. 1949. Growth of Norris Reservoir walleye during the first twelve years of impoundment. Journ. Wildlife Management, Vol. 13, No. 2, pp. 157-177.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1956